SUPPRESSION WITHIN A SIMULATED COMPUTER CABINET USING AN EXTERNAL WATER SPRAY*

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A total ban on halon production has created a vacuum in the fire protection industry which is likely to be filled by more than one suitable replacement. A water-based system is an attractive replacement candidate because water, in addition to being an effective fire suppressant, is non-toxic, environmentally friendly and competitively priced. The latest generation of spray systems requires much less water than traditional sprinklers, and is being considered for applications heretofore limited to non-condensing agents such as halon 1301.

There are two fundamental differences between halon and water mist that make the direct substitution of one for the other problematic: (1) the dynamics controlling the transport of the liquid water droplets are completely different from the dynamics of vaporized 1301, and (2) water is a good conductor of electricity where 1301 is not. This project is looking at the applicability of mist systems for extinguishing fires in an environment containing data processing equipment; the issue of electrical conductivity is not addressed.

The first task was to define a representative electronics cabinet and room geometry, fuel load, and ignition source. This was done after reviewing the literature and having conversations with those familiar with the application. A scaled-down, mock electronics package was designed and a chamber built to contain the spray to emulate the physical system of interest. The test chamber is 1.68 m wide, 0.91 m deep, and 2.13 m high, with an exhaust fan at the center of the top to remove products of combustion after each test has been run. Two walls are glass to allow visual observation of the entire process.

The mock electronics cabinet is 0.5 m wide by 0.2 m deep and 0.4 m high, and is shown in Figure 1. The fuel is a 3 mm thick plate of polymethylmethacrylate (PMMA), placed vertically in an aluminum frame centered among a number of aluminum "circuit boards" spaced every 25 or 50 mm. Three fans are located near the bottom of the cabinet to simulate the flow of cooling air. Ignition is by a small natural gas line burner.

The influence on extinguishing efficiency of the nozzle geometry, location relative to the fire, water application rate, and the depth to which the fire is buried within the simulated cabinet are all parameters which have been examined. A phase-Doppler particle analyzer (PDPA) is used to determine the droplet size distribution and two components of velocity at locations internally near the fire in the circuit board and external to the cabinet. These data are key to relating the extinguishment event to conditions adjacent to the fire, and indicate the fate of the droplets as a function of different initial conditions in the spray.

A baseline study was performed to determine the amount of a gaseous agent (CF_3H) necessary to extinguish fires as a function of the extent to which the fire is buried within the simulated electronics cabinet. Trifluoromethane was used rather than halon 1301 because it is a proposed gaseous alternative total flooding agent, and is significantly less effective than halon 1301.

A minimum enclosure situation corresponds to a PMMA circuit board totally exposed to the air and water spray. This arrangement is the easiest to extinguish, and identifies the locations within the test chamber where there is the greatest likelihood of suppression. Figures 2 and 3 indicate the time required to suppress the PMMA sample following a 30 second preburn time as a function of position below the pressure jet nozzle. The pressure in Figure 2 is 2.1 MPa and the flow rate is 2.1 l/min. The pressure in Figure 3 is double that amount, and the corresponding flow is 2.9 l/min. The affect of pressure is to greatly expand the region in which extinguishment is possible in under 60 s. This is due partly to the greater flux of water and partly due to the increased momentum of the water spray.

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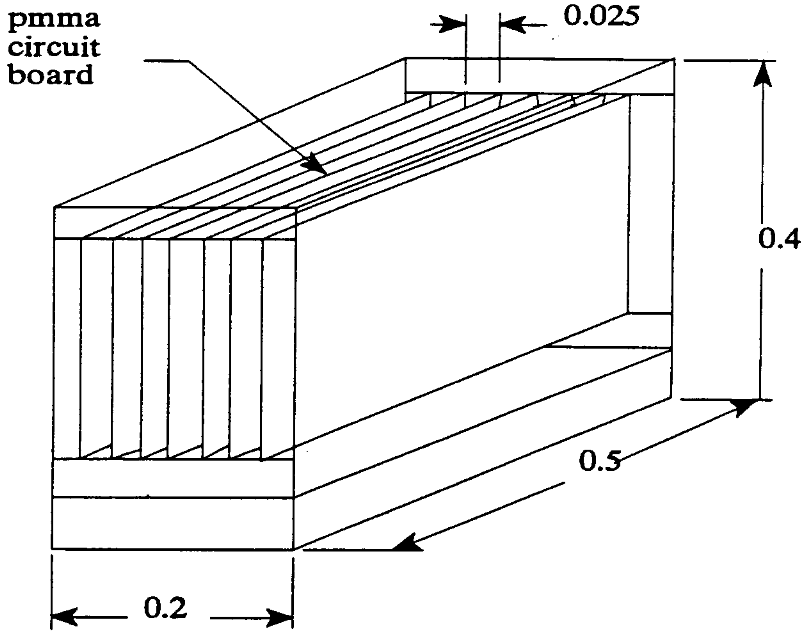

Figure 1. Schematic of mock electronics cabinet

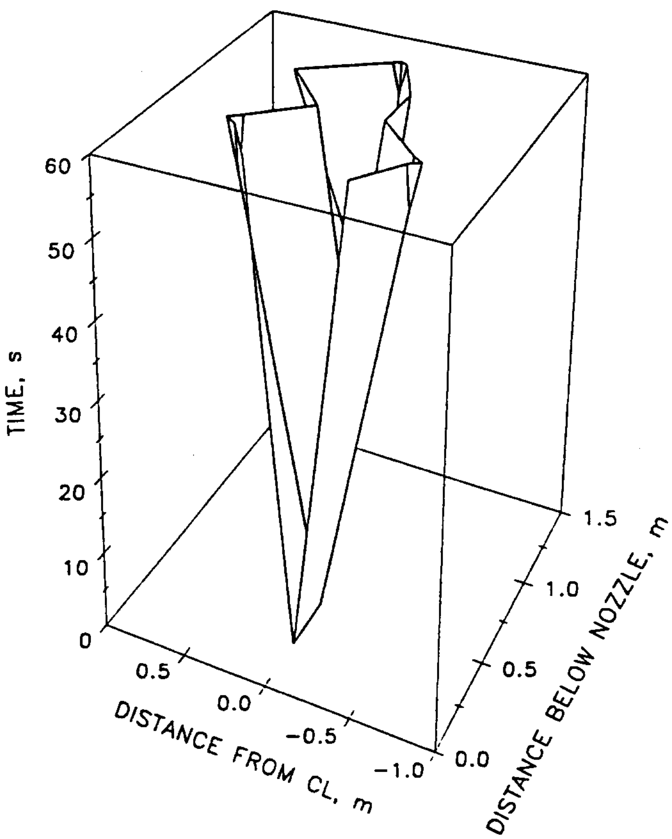

Figure 2. Time to extinction of flame (water pressure is 2.1 MPa)

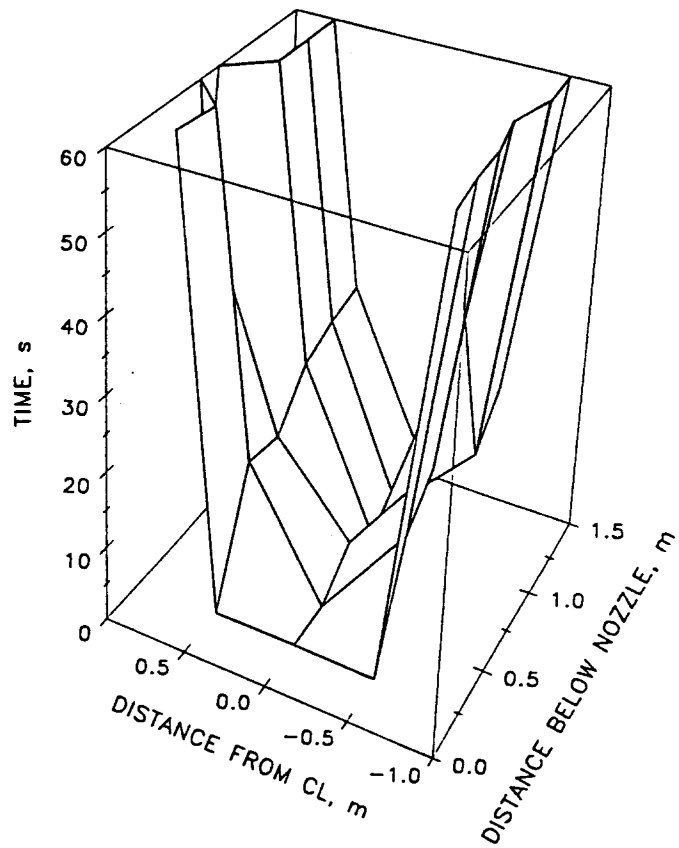

Figure 3. Time to extinction of flame (water pressure is 4.1 MPa)